COURSE OVERVIEW EE0295
Variable Frequency Drives (VFD)

Course Title
Variable Frequency Drives (VFD)

Course Date/Venue
October 07-11, 2024/Ras Al Khaimah Meeting Room, The Tower Plaza Hotel, Dubai, UAE

Course Reference
EE0295

Course Duration/Credits
Five days/3.0 CEUs/30 PDHs

Course Description

This practical and highly-interactive course includes real-life case studies and exercises Theory learnt will be applied using our state-of-the-art simulators.

It is estimated that electrical drives and other rotating equipment consume about 50% of the total electrical energy consumed in the world today. The cost of maintaining electrical motors can be a significant amount in the budget item of manufacturing, oil, gas, petrochemical and power industries. This course gives you a thorough understanding of operation, maintenance and failure modes of the Variable Frequency Drives (VFD) and gives you the tools to maintain and troubleshoot such Variable Frequency Drives (VFD).

Maximum efficiency, reliability, and longevity of the various types of Variable Frequency Drives (VFD) are of great concern to many industries. These objectives can only be achieved by understanding the characteristics, selection criteria, common problems and repair techniques, preventive and predictive maintenance. This course is a MUST for anyone who is involved in the selection, applications, operation or maintenance of Variable Frequency Drives (VFD). It provides the latest in technology. The course covers how these equipment operate and provides guidelines and rules that must be followed for a successful operation. Their basic design, operating characteristics, specification, selection criteria, advanced fault detection techniques, critical components as well as all maintenance issues are covered in detail.

The course is designed to provide participants with a comprehensive understanding of the various types of Variable Frequency Drives. Participants will be able to specify, select, commission and maintain these equipment for their applications. The excellent knowledge and skills that participants gained in this course will help their companies in achieving reduced capital, operating and maintenance costs along with increase in efficiency.

Course Objectives

Upon the successful completion of this course, each participant will be able to:-

- Apply and gain a good working knowledge on variable frequency drives (VFDs)
- Explain the basic principles of electrical machines, electrical devices, symbols and circuits
- Discuss electric motor types, operations and performance as well as the 3-phase AC induction motors including its basic construction, principles of operation, electrical and mechanical performance, etc
- Describe motor speed control, power electronic converters, protection of AC converters and motors
- Illustrate the control systems for AC variable frequency drives (VFD)
- Select AC converters and install and commission AC variable frequency speed drives (VFD)

Exclusive Smart Training Kit - H-STK®

*Participants of this course will receive the exclusive "Haward Smart Training Kit" (**H-STK®**). The **H-STK®** consists of a comprehensive set of technical content which includes **electronic version** of the course materials, sample video clips of the instructor's actual lectures & practical sessions during the course conveniently saved in a **Tablet PC**.*

Who Should Attend

This course provides an overview of all significant aspects and considerations of variable frequency drives (VFD) for those in charge of variable frequency drives and electrical motors including engineers, managers, technologists and other technical personnel.

Training Methodology

All our Courses are including **Hands-on Practical Sessions** using equipment, State-of-the-Art Simulators, Drawings, Case Studies, Videos and Exercises. The courses include the following training methodologies as a percentage of the total tuition hours:-

30% Lectures
20% Practical Workshops & Work Presentations
30% Hands-on Practical Exercises & Case Studies
20% Simulators (Hardware & Software) & Videos

In an unlikely event, the course instructor may modify the above training methodology before or during the course for technical reasons.

Course Certificate(s)

Internationally recognized certificates will be issued to all participants of the course who completed a minimum of 80% of the total tuition hours.

Certificate Accreditations

Certificates are accredited by the following international accreditation organizations: -

- The International Accreditors for Continuing Education and Training (IACET - USA)

  Haward Technology is an Authorized Training Provider by the International Accreditors for Continuing Education and Training (IACET), 2201 Cooperative Way, Suite 600, Herndon, VA 20171, USA. In obtaining this authority, Haward Technology has demonstrated that it complies with the **ANSI/IACET 2018-1 Standard** which is widely recognized as the standard of good practice internationally. As a result of our Authorized Provider membership status, Haward Technology is authorized to offer IACET CEUs for its programs that qualify under the **ANSI/IACET 2018-1 Standard**.

  Haward Technology's courses meet the professional certification and continuing education requirements for participants seeking **Continuing Education Units** (CEUs) in accordance with the rules & regulations of the International Accreditors for Continuing Education & Training (IACET). IACET is an international authority that evaluates programs according to strict, research-based criteria and guidelines. The CEU is an internationally accepted uniform unit of measurement in qualified courses of continuing education.

  Haward Technology Middle East will award **3.0 CEUs** (Continuing Education Units) or **30 PDHs** (Professional Development Hours) for participants who completed the total tuition hours of this program. One CEU is equivalent to ten Professional Development Hours (PDHs) or ten contact hours of the participation in and completion of Haward Technology programs. A permanent record of a participant's involvement and awarding of CEU will be maintained by Haward Technology. Haward Technology will provide a copy of the participant's CEU and PDH Transcript of Records upon request.

- British Accreditation Council (BAC)

  Haward Technology is accredited by the **British Accreditation Council** for **Independent Further and Higher Education** as an **International Centre**. BAC is the British accrediting body responsible for setting standards within independent further and higher education sector in the UK and overseas. As a BAC-accredited international centre, Haward Technology meets all of the international higher education criteria and standards set by BAC.

Course Fee

US$ 5,500 per Delegate + **VAT**. This rate includes H-STK® (Haward Smart Training Kit), buffet lunch, coffee/tea on arrival, morning & afternoon of each day.

Course Instructor(s)

This course will be conducted by the following instructor(s). However, we have the right to change the course instructor(s) prior to the course date and inform participants accordingly:

Dr. Ahmed El-Sayed,PhD, MSc, BSc, is a **Senior Instrumentation & Control Engineer** with over **30 years** of extensive experience in the **Oil**, **Gas**, **Power**, **Petroleum**, **Petrochemical** and **Utilities**. He specializes in **DCS & ESD** System Architecture, **Distributed Control System**, **DCS** & **SCADA**, Distributed Control System (**DCS**) Selection & Troubleshooting, **DCS**, **Process Control**, **Control Systems & Data Communications**, Advanced **DCS Yokogawa**, **Yokogawa CENTUM VP DCS**, **Modern Distributed Control System** (**DCS**) **& Process Instrumentation**, **Cyber Security** of Industrial System, **DCS System** (**Honeywell**), **DCS Experion** System, **DCS Siemens Telepherm XP**, **Measurement Devices & Control** System, Quality Measurement Instruments (**QMI**) **Analysers & Sample** Systems, **Instrumentation & Control** Systems, **Control System** Orientation, **Instrumentation Protection Devices** Maintenance & Testing, **Protection Devices** Troubleshooting, **Relay Coordination Using ETAP Software**, **Power System Study on ETAP**, **ETAP-Power System Analysis**, **Flow Measurement** Foundation, **Hydrocarbon** Measurement & Sampling, **Gas Dosiers** Preparation, **Gas/Liquid Fuel** Measurement, **Instrumentation Measurement & Control System**, **Flow** Measurement, **Pressure** Measurement, **Level & Temperature** Measurement, Uninterruptible Power Supply (**UPS**) **Battery Charger**, **Industrial UPS Systems Construction & Operation**, **Test Lead-Acid & Ni-cad Battery Systems**, **Hazards & Safe Work Practice**s, **Transformer** Operational Principles, Selection & Troubleshooting; **HV & LV Transformers**, **Control Valves & Actuators**, **Electrical Safety**, **Protection Relay Application**, **Maintenance & Testing**, **NEC** (National Electrical Code), **NESC** (National Electrical Safety Code), **Electrical Safety**, **Electrical Hazards Assessment**, **Electrical Equipment**, **Personal Protective Equipment**, Lock-Out & Tag-Out (**LOTO**), Confined Workspaces, Alerting Techniques, Electrical Transient Analysis Program (**ETAP**), Power **Quality**, Power **Network**, Power **Distribution**, **Distribution Systems**, **Power Systems Control**, **Power Systems Security**, Power **Electronics**, Electrical **Substations**, **UPS** & **Battery System**, **Earthing & Grounding**, Power **Generation**, **Protective Systems**, **Electrical Generators**, **Power** & **Distribution Transformers**, **Electrical Motors**, **Switchgears**, **Transformers**, **AC** & **DC Drives**, **Variable Speed Drives** & **Generators**, **Generator Protection**, **GE Gas Turbines**, PLC, SCADA, Instrumentation, Automation, Valve Tuning, SIS, SIL, ESD, Alarm Management Systems, Engine Management System, Bearing & Rotating Machine, Fieldbus Systems and Fiber Optics Technology. He is currently the **Systems Control Manager** of **Siemens** where he is in-charge of Security & Control of Power **Transmission Distribution** & **High Voltage** Systems and he further takes part in the Load Records Evaluation & Transmission Services Pricing.

During his career life, Dr. Ahmed has been actively involved in different Power System Activities including Roles in Power System Planning, Analysis, Engineering, **HV Substation** Design, Electrical Service Pricing, Evaluations & Tariffs, Project Management, Teaching and Consulting. His vast industrial experience was honed greatly when he joined many International and National Companies such as **Siemens**, **Electricity Authority** and **ACETO** industries as the **Instrumentation & Electrical Service Project Manager**, **Instrumentation & Control Engineer**, **Energy Management Engineer**, **Department Head**, **Assistant Professor**, **Instrumentation & Control Instructor**, **Project Coordinator**, **Project Assistant and Managing Board Member** where he focused more on dealing with Technology Transfer, System Integration Process and Improving Localization. He was further greatly involved in manufacturing some of **Power System** and **Control & Instrumentation Components** such as Series of Digital Protection **Relays**, MV **VFD**, **PLC** and **SCADA** System with intelligent features.

Dr. Ahmed is well-versed in different electrical and instrumentation fields like **ETAP**, Load Management Concepts, **PLC** Programming, Installation, Operation and Troubleshooting, **AC Drives** Theory, Application and Troubleshooting, Industrial Power Systems Analysis, AC & DC Motors, Electric Motor Protection, DCS SCADA, Control and Maintenance Techniques, Industrial Intelligent Control System, **Power Quality** Standards, Power Generators and Voltage Regulators, Circuit Breaker and Switchgear Application and Testing Techniques, **Transformer** and **Switchgear** Application, Grounding for Industrial and Commercial Assets, Power Quality and **Harmonics**, **Protective Relays** (O/C Protection, Line Differential, Bus Bar Protection and **Breaker Failure Relay**) and Project Management Basics (PMB).

Dr. Ahmed has **PhD**, **Master's** & **Bachelor's** degree in **Electrical Engineering** from the **University of Wisconsin Madison**, **USA** and **Ain Shams University**, respectively. Further, he is a **Certified Instructor/Trainer**, a **Certified Internal Verifier/ Assessor/Trainer** by the **Institute of Leadership and Management** (**ILM**), an active member of IEEE and ISA as well as numerous technical and scientific papers published internationally in the areas of Power Quality, Superconductive Magnetic Energy Storage, SMES role in Power Systems, Power System **Blackout** Analysis, and Intelligent Load Shedding Techniques for preventing Power System Blackouts, HV **Substation Automation** and Power System Stability.

Accommodation

Accommodation is not included in the course fees. However, any accommodation required can be arranged at the time of booking.

Course Program

The following program is planned for this course. However, the course instructor(s) may modify this program before or during the course for technical reasons with no prior notice to participants. Nevertheless, the course objectives will always be met:

Day 1: ***Monday 07th of October 2024***

0730 – 0745	*Registration & Coffee*
0745 – 0800	*Welcome & Introduction*
0800 – 0815	***PRE-TEST***
0815 – 0930	***Basic Principles of Electrical Machines*** *Introduction to Electrical Machines • AC Power Systems • Meters Used in Troubleshooting*
0930 – 0945	*Break*
0945 – 1100	***Electrical Devices, Symbols & Circuits*** *Devices and Symbols • Electrical Circuits • Reading and Understanding Electrical Drawings • Reading and Understanding Ladder Logic • Wires and Terminal Numbering*
1100 - 1230	***Electric Motors Types, Operations & Performance*** *Fundamentals of Motor Technology • Basic Principles of Rotating Electrical Machines • Fundamental Principles of Speed Control • Efficiency, Torque, Inertia, Horsepower/Power Factor*
1230 – 1245	*Break*
1245 – 1420	***Electric Motors Types, Operations & Performance (cont'd)*** *Torque-Speed Curves • Induction/Wound Rotor/Synchronous Motor Types • Basic Construction of a Motor • Principles of Operation and Performance*
1420 - 1430	***Recap***
1430	*Lunch & End of Day One*

Day 2: ***Tuesday 08th of October 2024***

0730 – 0930	***3-Phase AC Induction Motors*** *Basic Construction • Principles of Operation • The Equivalent Circuit • Electrical and Mechanical Performance*
0930 – 0945	*Break*
0945 – 1100	***3-Phase AC Induction Motors (cont'd)*** *Motor Acceleration • AC Induction Generator Performance • Efficiency of Electric Motors*
1100 - 1230	***3-Phase AC Induction Motors (cont'd)*** *Rating of AC Induction Motors • Electric Motor Duty Cycles • Cooling and Ventilation of Electric Motors (IC) • Degree of Protection of Motor Enclosures (IP)*
1230 – 1245	*Break*
1245 – 1420	***3-Phase AC Induction Motors (cont'd)*** *Construction and Mounting of AC induction Motors • Anti-Condensation Heaters • Methods of Starting AC Induction Motors*
1420 - 1430	***Recap***
1430	*Lunch & End of Day Two*

Day 3: **Wednesday 09th of October 2024**

0730 – 0930	***Motor Speed Control*** *The Need for Variable Speed Drives • Fundamental Principles • Torque-Speed Curves for Variable Speed Drives • Types of Variable Speed Drives*
0930 – 0945	*Break*
0945 – 1100	***Motor Speed Control (cont'd)*** *Mechanical Variable Speed Drive Methods • Hydraulic Variable Speed Drive Methods • Electromagnetic or 'Eddy Current' Coupling • Electrical Variable Speed Drive Methods*
1100 – 1230	***Power Electronic Converters*** *Power Diodes • Power Thyristors • Commutation • Power Electronic Rectifiers (AC/DC Converters)*
1230 – 1245	*Break*
1245 – 1420	***Power Electronic Converters (cont'd)*** *Gate Commutated Inverters (DC/AC Converters) • Gate Controlled Power Electronic Devices • Other Power Converter Circuit Components*
1420 – 1430	***Recap***
1430	*Lunch & End of Day Three*

Day 4: **Thursday 10th of October 2024**

0730 – 0930	***Protection of AC Converters & Motors*** *AC Frequency Converter Protection Circuits • Operator Information and Fault Diagnostics • Electric Motor Protection*
0930 – 0945	*Break*
0945 – 1100	***Protection of AC Converters & Motors (cont'd)*** *Thermal Overload Protection - Current Sensors • Thermal Overload Protection - Direct Temperature Sensing*
1100 – 1230	***Control Systems for AC Variable Frequency Drives (VFD)*** *The Overall Control System • Power Supply to the Control System • The DC Bus Charging Control System • The PWM Rectifier for AC Converters*
1230 – 1245	*Break*
1245 – 1420	***Control Systems for AC Variable Frequency Drives (VFD) (cont'd)*** *Variable Speed Drive Control Loops • Vector Control for AC Drives • Current Feedback in AC Variable Speed Drives • Speed Feedback from the Motor*
1420 - 1430	***Recap***
1430	*Lunch & End of Day Four*

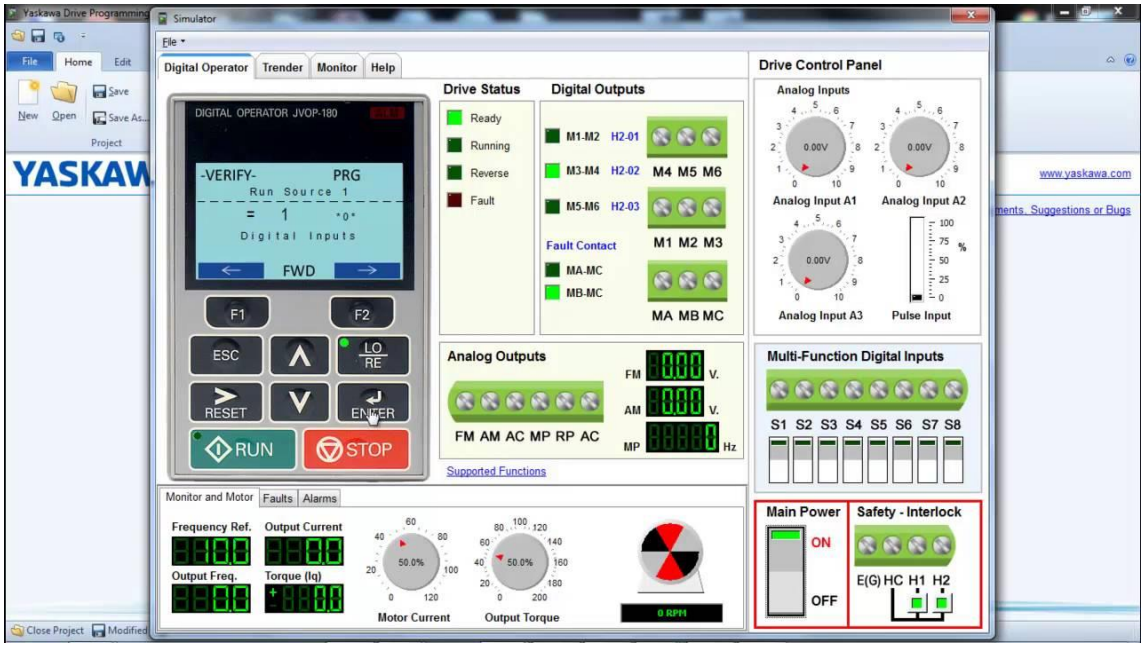
Day 5: **Friday 11th of October 2024**

0730 – 0930	***Selection of AC Converters*** *The Basic Selection Procedure • The Load ability of Converter Fed Squirrel Cage Motors • Operation in the Constant Power Region • The Nature of the Machine Load*
0930 – 0945	*Break*
0945 – 1100	***Selection of AC Converters (cont'd)*** *The Requirements for Starting • The Requirements for Stopping • Control of Speed, Torque and Accuracy • Selecting the Correct Size of Motor and Converter*
1100 – 1230	***Installation & Commissioning of AC Variable Frequency Drives (VFD)*** *General Installation and Environmental Requirements • Power Supply Connections and Earthing Requirements • Start/Stop Control of AC Drives*

1230 – 1245	*Break*
1245 – 1345	***Installation & Commissioning of AC Variable Frequency Drives (VFD) (cont'd)*** *Installing AC Converters Into Metal Enclosures • Control Wiring for Variable Speed Drives • Commissioning Variable Speed Drives*
1345 -1400	***Course Conclusion***
1400 – 1415	***POST-TEST***
1415 – 1430	*Presentation of Course Certificates*
1430	*Lunch & End of Course*

Simulators (Hands-on Practical Sessions)

Practical sessions will be organized during the course for delegates to practice the theory learnt. Delegates will be provided with an opportunity to carryout various exercises using our state-of-the-art "Yaskawa Programming Simulator".



YASKAWA Programming Simulator

Course Coordinator

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